(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 469 116 A2

# (12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
**20.10.2004 Bulletin 2004/43**

(51) Int Cl.[7]: **D06F 35/00**

(21) Application number: **04250194.0**

(22) Date of filing: **15.01.2004**

(84) Designated Contracting States:
**AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IT LI LU MC NL PT RO SE SI SK TR**
Designated Extension States:
**AL LT LV MK**

(30) Priority: **18.04.2003 KR 2003024836**

(71) Applicant: **Samsung Electronics Co., Ltd.**
**Suwon-si, Gyeonggi-do (KR)**

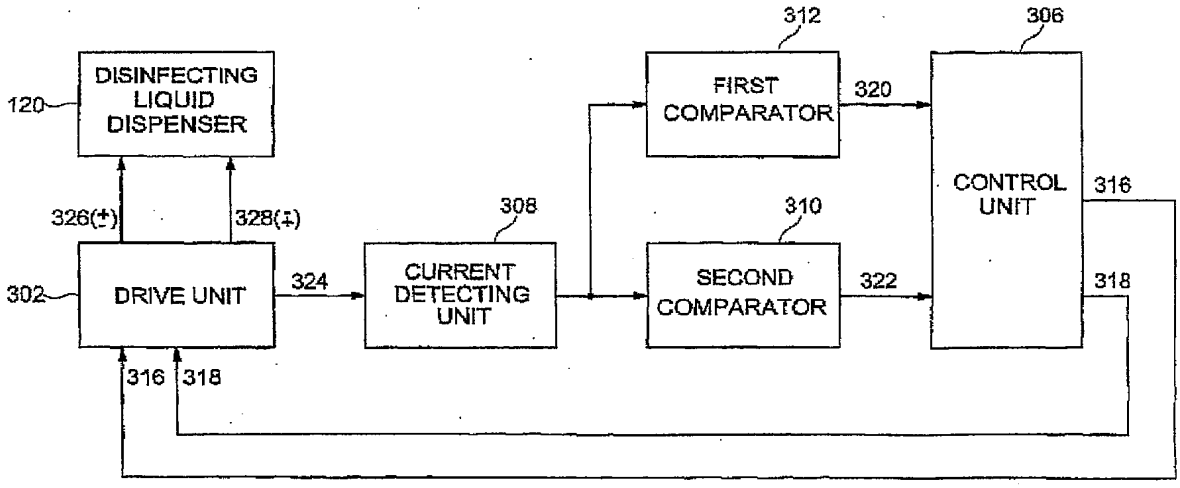
(72) Inventors:
- **Park, Seon-Woo**
  **Suwon-City Kyungki-Do (KR)**
- **Kim, Young-Hyun**
  **Suwon-City Kyungki-Do (KR)**

(74) Representative: **Robinson, Ian Michael et al**
**Appleyard Lees,**
**15 Clare Road**
**Halifax HX1 2HY (GB)**

## (54) Washing machine with disinfecting dispenser and method of controlling the same

(57) A washing machine and method of controlling the same. The washing machine has: a disinfecting liquid dispenser (120), a drive unit (302), a comparator unit (310,312) and a control unit (306). The disinfecting liquid dispenser (120) provides a disinfecting liquid to disinfect laundry. The drive unit (302) generates first and second control voltages (326,328) and outputs the first and second control voltages (326,328) to the disinfecting liquid dispenser (120), to control a concentration of the disinfecting liquid. The comparator unit (310,312) determines whether the concentration of the disinfecting liquid falls within a predetermined range. And the control unit (306) controls the drive unit (302) so that the concentration of the disinfecting liquid has a value within the predetermined range.

FIG. 3




EP 1 469 116 A2

## Description

**[0001]** The present invention relates generally to a washing machine, and, more particularly, to a washing machine equipped with a disinfecting liquid dispenser, and a method of controlling the washing machine.

**[0002]** Disinfecting washing machines may be classified into disinfecting washing machines using ozone and disinfecting washing machines using silver ions. Of these disinfecting washing machines, disinfecting washing machines using silver ions are equipped with disinfecting fluid dispensers that produce and supply a silver solution to disinfect laundry through antibacterial and bactericidal actions of the silver solutions.

**[0003]** The silver solution is produced by forming silver ions ($Ag^+$) and dissolving them into water. The silver solution is used as an antibacterial agent or a bactericide. It is reported that such a silver solution eliminates about 650 kinds of bacteria. In particular, the silver solution is characterized as not inducing resistance, which is different from general antibiotics, and is safe because the silver solution has no toxic effects on humans. Methods of manufacturing silver solutions include an electrolysis method, a chemical resolution method, and a pulverization method. Of these methods, the electrolysis method is most effective at dissolving the silver ions into the water.

**[0004]** A disinfecting effect of the silver solution is determined based on a concentration of the silver solution. That is, when the concentration of the silver solution is excessively low, the disinfecting effect is reduced. In contrast, when the concentration of the silver solution is excessively high, laundry may be discolored. Accordingly, the concentration of the silver solution needs to be controlled, to provide a sufficient disinfecting effect without discoloring the laundry. Further, to produce a silver solution of an appropriate concentration, voltages applied to silver plates of a silver ion generating device must be controlled within an appropriate range.

**[0005]** It is an aim of the present invention to provide a washing machine and a method of controlling the washing machine, which can maintain a concentration of a silver solution within a predetermined appropriate range, and ideally to provide a sufficient disinfecting effect without discoloring laundry with the silver solution.

**[0006]** Other aims and/or advantages of the invention will be set forth in part in the description which follows and, in part, will be obvious from the description, or may be learned by practice of the invention.

**[0007]** According to the present invention there is provided an apparatus and method as set forth in the appended claims. Preferred features of the invention will be apparent from the dependent claims, and the description which follows.

**[0008]** In one aspect of the present invention there is provided a washing machine including a disinfecting liquid dispenser to provide a disinfecting liquid to disinfect laundry, a drive unit to generate first and second control voltages, and to output the first and second control voltages to the disinfecting liquid dispenser to control a concentration of the disinfecting liquid, a comparator unit to determine whether the concentration of the disinfecting liquid falls within a predetermined range, and a control unit to control the drive unit so that the concentration of the disinfecting liquid has a value within the predetermined range.

**[0009]** In another aspect of the present invention there is provided a method of controlling a washing machine, the washing machine having a disinfecting liquid dispenser to provide a disinfecting liquid to disinfect laundry, and a drive unit to generate first and second control voltages, and to output the first and second control voltages to the disinfecting liquid dispenser to control a concentration of the disinfecting liquid, the method including determining an amount of driving current using the first and second control voltages, continuously generating the first and second control voltages if the amount of driving current falls within a predetermined range, and restricting an operation of the washing machine if the amount of driving current deviates from the predetermined range.

**[0010]** For a better understanding of the invention, and to show how embodiments of the same may be carried into effect, reference will now be made, by way of example, to the accompanying diagrammatic drawings in which:

Figure 1 is a sectional view showing a washing machine, according to an embodiment the present invention;

Figure 2 is a partial sectional view showing a disinfecting liquid dispenser of the washing machine of Figure 1;

Figure 3 is a block diagram showing a silver solution concentration control device of the washing machine of Figure 1;

Figure 4 is a circuit diagram showing a drive unit of the silver solution concentration control unit of Figure 3;

Figures 5A to 5D are waveform diagrams of signals applied to the drive unit of Figure 4; and

Figure 6 is a flowchart showing a method of controlling a concentration of a silver solution of the washing machine of Figure 2.

**[0011]** A washing machine and method of controlling the washing machine are described with reference to Figures 1 to 6. Figure 1 is a sectional view showing the washing machine. As is shown in Figure 1, a water tub 104 is disposed in a body casing 102 to contain washing water. A washing tub 106 is disposed in the water tub

104. A pulsator 108 is positioned in a lower portion of an interior of the washing tub 106, and is rotated in forward and reverse directions to create currents of washing water. A drive unit 110 is positioned under the water tub 104 to rotate the washing tub 106 and the pulsator 108. The drive unit 110 includes a drive motor 112 and a power transmission unit 114. The drive motor 112 is rotated by power supplied thereto, and the power transmission unit 114 serves to selectively transmit power generated by the drive motor to the pulsator 108 and the washing tub 106. A belt 116 is wound around the drive motor 112 and the power transmission device 114 to mediate the transmission of power.

**[0012]** Figure 2 is a partial sectional view showing a disinfecting liquid dispenser 120 of the washing machine. As is depicted in Figure 2, when a washing course is selected after power is supplied to the washing machine and laundry is put into the washing machine, washing water is fed into an interior of a water tub 104. The washing water fed into the water tub 104 dissolves a detergent while passing through a detergent dispenser (not shown), and is supplied to the water tub 104 along with the dissolved detergent.

**[0013]** If a user selects a disinfection washing course, an inlet valve 204 of the disinfecting liquid dispenser 120 is opened and water is supplied to an interior of a storage container 122, at the same time that the washing water is fed to the water tub 104. When power is applied to two silver plates 220 and 222 of the disinfecting liquid dispenser 120, a silver disinfecting liquid is produced. This silver disinfecting liquid is supplied to the interior of the washing tub 106 and disinfects the laundry.

**[0014]** The water supplied though an inlet 202 of the storage container 122 is halted to stabilize a flowing speed and a flow thereof while filling a first space 210 of the storage container 122. The water contained in the first space 210 overflows a first partition 206 and flows into a second space 214. The water having passed through the first space 210 and flowing into the second space 214 fills the second space 214 to a water level corresponding to the height of a second partition 208. After the second space 214 is filled with the water, the water overflows the second partition 208 into a third space 224, and then is supplied to the interior of the water tub 104 through an outlet 216 of the storage container 122. In this case, the water contained in the second space 214 flows into the third space 224 while a certain amount of water is contained in the second space 214. In this process, the silver disinfecting liquid is produced through electrolysis in the water, and the produced disinfecting liquid is supplied to the washing water 106 through the outlet 216. The process of producing such disinfecting liquid is continuously carried out while the water is supplied to the storage container 122.

**[0015]** Additionally, in the process of producing the disinfecting liquid, if the amount of water supplied through the inlet 202 is large, water contained in the interior of the storage container 122 flows into a drain pipe 118a through a bypass pipe 128, so that water is maintained at an appropriate water level in the storage container 122, thereby enabling production of the disinfecting liquid at a certain concentration. When the process of producing the disinfecting liquid is stopped, water supply to the storage container 122 is stopped by the closing of the inlet value 204, and power application to the silver plates 220 and 222 is stopped. At this time, water remaining in the interior of the storage container 122 flows into the outlet 216 through remaining water discharging holes 206a and 208a and is completely discharged from the storage container 122.

**[0016]** After washing water including the disinfecting liquid fills the water tub 104, the washing of the laundry is performed by the rotation of the pulsator 108 and bacteria are killed by the disinfecting liquid in the process of washing the laundry.

**[0017]** The disinfecting liquid dispenser 120 carries out electrolysis in the water by alternately applying positive and negative voltages to the two silver plates 220 and 222, thus generating silver ions. In this case, an amount of silver ions, that is, the concentration of a silver solution, is proportional to an amount of current flowing through the two silver plates 220 and 222, and is also proportional to a magnitude of the voltages applied to the two silver plates 220 and 222.

**[0018]** Figure 3 is a block diagram showing a silver solution concentration control device, with which the washing machine is equipped. As is shown in Figure 3, a drive unit 302 allows silver solution to be produced by alternately applying positive and negative voltages to the disinfecting liquid dispenser 120. A polarity of a voltage applied from the drive unit 302 to the disinfecting liquid dispenser 120 is controlled by first and second switching signals 316 and 318 output from a control unit 306 to the drive unit 302.

**[0019]** An amount of current supplied to the disinfecting liquid dispenser is proportional to the magnitude of the applied voltages, which is estimated based on a driving current 324 flowing through the drive unit 302. If an amount of the driving current 324 exceeds a predetermined highest limit of a range that is required to produce a silver solution of a concentration suitable for disinfection of laundry, the control unit 306 prevents silver ions from being generated by stopping application of the first and second switching signals 316 and 318. If the amount of the driving current 324 is reduced to less than a predetermined lowest limit of the range, the control unit 306 takes an appropriate protective measure.

**[0020]** Reduction of the driving current 324 is caused in situations in which water is not supplied through the disinfecting liquid dispenser 120, or an amount of supplied water is insufficient, and may be caused by poor attachment of the silver plates 202 and 222 or disconnection of a power line. Accordingly, if the driving current 324 of the drive unit 302 is reduced to less than the lowest limit, the control unit 306 generates an alarm to warn a user and temporarily stops operation of the washing

machine.

**[0021]** If the amount of the driving current 324 detected by a current detecting unit 308 exceeds the highest limit, a first comparator 312 generates an excessive current signal 320 and outputs the excessive current signal 320 to the control unit 306. When the first comparator 312 generates the excessive current signal 320, the control unit 306 stops generation of silver ions in the disinfecting liquid dispenser 120 by blocking at least one of the first and second switching signals 316 and 318. When the generation of silver ions is stopped while water is supplied to the disinfecting liquid dispenser 120, a concentration of silver ions of the disinfecting liquid is reduced.

**[0022]** If the amount of the driving current 324 detected by a current detecting unit 308 is less than a preset lowest limit, a second comparator 310 generates an insufficient current signal 322 and outputs the insufficient current signal 322 to the control unit 306. When the second comparator 310 generates the insufficient current signal 322, the control unit 306 generates an alarm to warn the user, and temporarily stops the operation of the washing machine.

**[0023]** The highest and lowest limits of the driving current 324 applied by the first and second first and second comparators 312 and 310 of the washing machine according to the embodiment of the present invention are bases to provide a sufficient disinfecting effect as well as to prevent laundry from being discolored by the silver solution. For this purpose, in a development stage of the washing machine, an optimal concentration of the silver solution to provide a sufficient disinfecting effect as well as to prevent laundry from being contaminated with the silver solution is obtained through experiments. The highest and lowest values of the driving current 324 required to realize the optimal concentration of the silver solution are thus obtained and set, thereby not only preventing laundry from being discolored by the silver solution, but also providing a sufficient disinfecting effect.

**[0024]** A construction of the drive unit 302 that controls the concentration of the silver solution contained in the disinfecting liquid dispenser 120 is described below with reference to Figures 4 and 5A to 5D. Figure 4 is a circuit diagram of the drive unit 302 of the silver solution concentration control unit. As is shown in Figure 4, NPN bipolar transistors 402 and 404 create a series circuit between a source voltage VCC and a ground GND. NPN bipolar transistors 406 and 408 form another series circuit in parallel with the NPN bipolar transistors 402 and 404.

**[0025]** The NPN bipolar transistors 402 and 408 are controlled by the first switching signal 316, whereas the NPN bipolar transistors 404 and 406 are controlled by the second switching signal 318. A first control voltage 326 output between the NPN bipolar transistors 402 and 404 is applied to one of the two silver plates 220 and 222 of the disinfecting liquid dispenser 120. A second control voltage 328 output between the NPN bipolar transistors 406 and 408 is applied to the other silver plate. In Figure 4, an emitter current of the NPN bipolar transistors 404 and 408 is the driving current 324 that is an entire current flowing through the drive unit 302. As described in connection with Figure 3, the driving current 324 is detected by the current detecting unit 308, and is supplied to the first and second comparators 312 and 310.

**[0026]** Figures 5A to 5D are waveform diagrams of signals applied to the drive unit 302 of the silver solution concentration control device of Figure 4. As is shown in Figures 5A to 5D, phases of the first and second switching signals 316 and 318, which are input signals, are opposite to each other. A certain dead time $t_d$ exists between transition points of the first and second switching signals 316 and 318. If there were no dead time $t_d$, and the first and second switching signals 316 and 318 made transitions at the same time, a range in which the two signals 316 and 318 overlap each other would be created, and the two silver plates 220 and 222 would be short-circuited. If the dead time $t_d$ is set between the transition points of the first and second switching signals 316 and 318, the two silver plates 220 and 222 of the disinfecting liquid dispenser 120 are prevented from being short-circuited.

**[0027]** Like the first and second switching signals 316 and 318, the first and second control signals 326 and 328, that are output signals, are opposite to each other. A phase of the first control voltage 326 is identical with a phase of the first switching signal 316, whereas a phase of the second control voltage 328 is identical with a phase of the second switching signal 318.

**[0028]** An operation of controlling the concentration of the silver solution of the disinfecting liquid dispenser 120 is described with reference to Figures 4 and 5A to 5D. In Figures 5A to 5D, when the first switching signal 316 is at a high level and the second switching signal 318 is at a low level, only the NPN bipolar transistors 402 and 408 of Figure 4 are turned on, so that the source voltage VCC is applied to the ground GND through the NPN bipolar transistor 402, the disinfecting liquid dispenser 120 and the NPN bipolar transistor 408. In this case, voltages are applied to the two silver plates 220 and 222 of the disinfecting liquid dispenser 120; the first control voltage 326 has a positive polarity and the second control voltage 328 has a negative polarity.

**[0029]** When the first switching signal 316 is at a low level and the second switching signal 318 is at a high level as a result of a phase change, only the NPN bipolar transistors 406 and 404 of Figure 4 are turned on, so that the source voltage VCC is applied to the ground GND through the NPN bipolar transistor 406, the disinfecting liquid dispenser 120 and the NPN bipolar transistor 404. In this case, voltages are applied to the two silver plates 220 and 222 of the disinfecting liquid dispenser 120; the first control voltage 326 has a negative polarity and the second control voltage 328 has a positive polarity.

**[0030]** As described above, the polarities of the first and second control voltages 316 and 318 output from the drive unit 302 to the disinfecting liquid dispenser 120 are changed by the first and second switching signals 316 and 318. Since the first and second control voltages 326 and 328 are voltages that are applied to the two silver plates of the disinfecting liquid dispenser 120, a silver solution is produced in the disinfecting liquid dispenser 120 while the first and second control voltages 326 and 328 are applied.

**[0031]** Figure 6 is a flowchart showing a method 600 of controlling the concentration of the silver solution of the washing machine. As is shown in Figure 6, when a disinfection washing mode starts in operation 602, the first and second switching signals 316 and 318 are applied to generate the first and second control voltages 326 and 328 in operation 604. Next, it is determined whether the driving current 324 falls within a range between the predetermined highest limit $I_{max}$ and the predetermined lowest limit $I_{min}$ by detecting the driving current 324 flowing through the drive unit 302, in operation 608, and comparing the driving current 324 with currents of the range using the first and second comparators 320 and 322 in operation 610.

**[0032]** If the driving current 324 falls within the range between the highest limit $I_{max}$ and the lowest limit $I_{min}$ in operation 610, the first and second switching signals 316 and 318 are continuously applied in operation 612, and a washing process is terminated after a time set for the washing process elapses in operation 614.

**[0033]** If the driving current 324 exceeds the highest limit $I_{max}$ in operation 616, the concentration of the silver solution is prevented from being increased by blocking the first and second switching signals 316 and 318 in operation 618, and the method 600 returns to operation 610 to determine whether the driving current 324 falls within the predetermined range.

**[0034]** If it is determined in operation 616 that the driving current 324 does not exceed the highest limit $I_{max}$, then in operation 620, it is determined whether the driving current 324 is less than the lowest limit $I_{min}$. If the driving current 324 is less than the lowest limit $I_{min}$ in operation 620, an alarm is generated in operation 622 and operation of the washing machine is stopped.

**[0035]** As described above, the control unit 306 of the washing machine determines whether a concentration of a currently produced silver solution falls within an appropriate range and controls the silver solution to have an appropriate concentration by monitoring an amount of current flowing between the two silver plates 220 and 222 of the disinfecting liquid dispenser 120.

**[0036]** As is apparent from the above description, the present invention provides the washing machine and the method of controlling the same, which can maintain the concentration of the silver solution within the appropriate range that is required to provide a sufficient disinfecting effect as well as to prevent laundry from being discolored by the silver solution, by controlling the magnitude of voltages 336 and 328 applied to the silver plates 220 and 222 according to the concentration of the silver solution.

**[0037]** Although a few preferred embodiments have been shown and described, it will be appreciated by those skilled in the art that various changes and modifications might be made without departing from the scope of the invention, as defined in the appended claims.

**[0038]** Attention is directed to all papers and documents which are filed concurrently with or previous to this specification in connection with this application and which are open to public inspection with this specification, and the contents of all such papers and documents are incorporated herein by reference.

**[0039]** All of the features disclosed in this specification (including any accompanying claims, abstract and drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive.

**[0040]** Each feature disclosed in this specification (including any accompanying claims, abstract and drawings) may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated otherwise, each feature disclosed is one example only of a generic series of equivalent or similar features.

**[0041]** The invention is not restricted to the details of the foregoing embodiment(s). The invention extends to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed.

## Claims

1. A washing machine, comprising:

   a disinfecting liquid dispenser (120) to provide a disinfecting liquid to disinfect laundry;

   a drive unit (302) to generate first and second control voltages (326,328), and to output the first and second control voltages (326,328) to the disinfecting liquid dispenser (120) to control a concentration of the disinfecting liquid;

   a comparator unit (310,312) to determine whether the concentration of the disinfecting liquid falls within a predetermined range; and

   a control unit (306) to control the drive unit (302) so that the concentration of the disinfecting liquid has a value within the predetermined range.

2. The washing machine as set forth in claim 1, wherein:

the disinfecting liquid dispenser (120) comprises at least two silver plates (220,222); and

the disinfecting liquid is a silver solution that is produced through electrolysis performed by applying the first and second control voltages (326,328) to the at least two silver plates (220,222).

3. The washing machine as set forth in claim 2, wherein:

the concentration of the silver solution is determined by respective levels of the first and second control voltages (326,328).

4. The washing machine as set forth in any preceding claim, further comprising:

a current detecting unit (308) to determine an amount of current supplied from the drive unit (302) to the disinfecting liquid dispenser (120);

wherein the comparator unit (310,312) determines whether the concentration of the disinfecting liquid falls within the predetermined range based on the determined amount of current.

5. The washing machine as set forth in any preceding claim, wherein the comparator unit (310,312) comprises:

a first comparator (312) to output a first current signal to the control unit (306) if the amount of current is more than a highest limit of the predetermined range; and

a second comparator (310) to output a second current signal to the control unit (306) if the amount of current is less than a lowest limit of the predetermined range,

wherein the control unit (306) reduces the concentration of the disinfecting liquid by controlling the drive unit (302) if the excessive current signal is generated, and generates an alarm if the insufficient current signal is generated.

6. The washing machine as set forth in any preceding claim, wherein the drive unit (302) comprises:

first and second switching circuits (402-408) that receive first and second switching signals alternating between first and second levels and having opposite phases, and respectively output the first and second control voltages (326,328), which have opposite phases.

7. The washing machine as set forth in claim 6, wherein:

the first and second switching circuits (402-408) are alternately turned on by the first and second switching signals, so that the first and second control voltages (326,328) have phases and periods substantially identical with those of the first and second switching signals.

8. A method of controlling a washing machine, the washing machine having a disinfecting liquid dispenser (120) to provide a disinfecting liquid to disinfect laundry, and a drive unit (302) to generate first and second control voltages (326,328), and to output the first and second control voltages (326,328) to the disinfecting liquid dispenser (120) to control a concentration of the disinfecting liquid, the method comprising:

determining an amount of driving current using the first and second control voltages (326,328);

continuously generating the first and second control voltages (326,328) if the amount of driving current falls within a predetermined range; and

restricting an operation of the washing machine if the amount of driving current deviates from the predetermined range.

9. The method as set forth in claim 8, wherein:

the generating of the first and second control voltages (326,328) is stopped if the amount of driving current exceeds a highest limit of the predetermined range; and

an alarm is generated and the operation of the washing machine is stopped if the amount of driving current is reduced to less than a lowest limit of the predetermined range.

10. An apparatus, comprising:

a disinfecting liquid dispenser (120) dispensing a disinfecting liquid to a washing machine;

a driver (302) outputting first and second control voltages (326,328) to the disinfecting liquid dispenser (120) to control a concentration of the disinfecting liquid;

a comparator (310,312) determining whether a

concentration of the disinfecting liquid is within a predetermined range; and

a controller (306), controlling the driver (302) outputting the first and second control voltages (326,328) based on the determination of the comparator (310,312).

**11.** The apparatus according to claim 10, wherein:

the controller (306) outputs first and second switching signals to respectively control the driver (302) outputting the first and second control voltages (326,328).

**12.** The apparatus according to claim 11, wherein:

the comparator (310,312) sends a first signal to the controller (306) if the concentration of the disinfecting liquid exceeds the predetermined range; and

the comparator (310,312) sends a second signal to the controller (306) if the concentration of the disinfecting liquid is below the predetermined range.

**13.** The apparatus according to claim 12, wherein the comparator (310,312) comprises:

a first comparator (312) sending the first signal; and

a second comparator (310) sending the second signal.

**14.** The apparatus according to claim 12 or 13, wherein:

when the controller (306) receives the first signal, the controller (306) outputs the first and second switching signals to respectively reduce the first and second control voltages (326,328); and

when the controller (306) receives the second signal, the controller (306) generates an alarm.

**15.** The apparatus according to claim 14, wherein:

when the controller (306) receives the second signal, the controller (306) also shuts off the apparatus.

**16.** The apparatus according to any of claims 10 to 15, further comprising:

a current detector determining an amount of current flowing through the driver (302), wherein the comparator (310,312) determines whether the concentration of the disinfecting liquid is within the predetermined range based on the determined amount of current.

**17.** The apparatus according to any of claims 10 to 16, wherein the disinfecting liquid dispenser (120) comprises:

at least two metal plates (220,222);

wherein the first and second control voltages (326,328) are applied to the at least two metal plates (220,222) to produce metal ions in the disinfecting liquid through electrolysis.

**18.** The apparatus according to claim 17, wherein:

the at least two metal plates (220,222) are silver;

the metal ions are silver ions; and

the concentration of the disinfecting liquid is the concentration of silver in the disinfecting liquid.

**19.** The apparatus according to claim 18, wherein:

when the concentration of silver in the disinfecting liquid is within the predetermined range, the disinfecting liquid provides an antibacterial effect to an item being washed in the washing machine without discoloring the item.

**20.** The apparatus according to claim 11, wherein the driver (302) comprises:

first and second switching circuits (402-408), respectively receiving the first and second switching signals, wherein the first and second switching signals each alternate between first and second levels, have opposite phases, and respectively output the first and second control voltages (326,328) such that the first and second control voltages (326,328) have opposite phases.

**21.** The apparatus according to claim 20, wherein:

the first and second switching circuits (402-408) are alternately turned on by the first and second switching signals, so that the first and second control voltages (326,328) have phases and periods respectively identical with those of the first and second switching signals.

**22.** A method to control an apparatus including a driver (302) and a disinfecting liquid dispenser (120), the

method comprising:

outputting first and second control voltages (326,328) from the driver (302) to the disinfecting liquid dispenser (120);

determining a magnitude of a driving current flowing through the driver (302);

determining whether the magnitude of the driving current is within a predetermined range;

if the magnitude of the driving current is within the predetermined range, maintaining the first and second control voltages (326,328) for a predetermined amount of time;

if the magnitude of the driving current is greater than the predetermined range, reducing the first and second control voltages (326,328); and

if the magnitude of the driving current is less than the predetermined range, generating an alarm.

**23.** A washing machine, comprising:

a disinfecting liquid dispenser (120); and
at least two silver plates (220,222), wherein the washing machine maintains a concentration of a silver solution in an appropriate range to provide a sufficient disinfecting effect and prevent laundry from being discolored, by controlling a magnitude of voltages applied to the at least two silver plates (220,222) according to the concentration of the silver solution.

**24.** A method, comprising:

controlling a magnitude of voltages applied to silver plates according to a concentration of a silver solution, to maintain the concentration of the silver solution in an appropriate range to provide a sufficient disinfecting effect and prevent laundry from being discolored.

FIG. 1

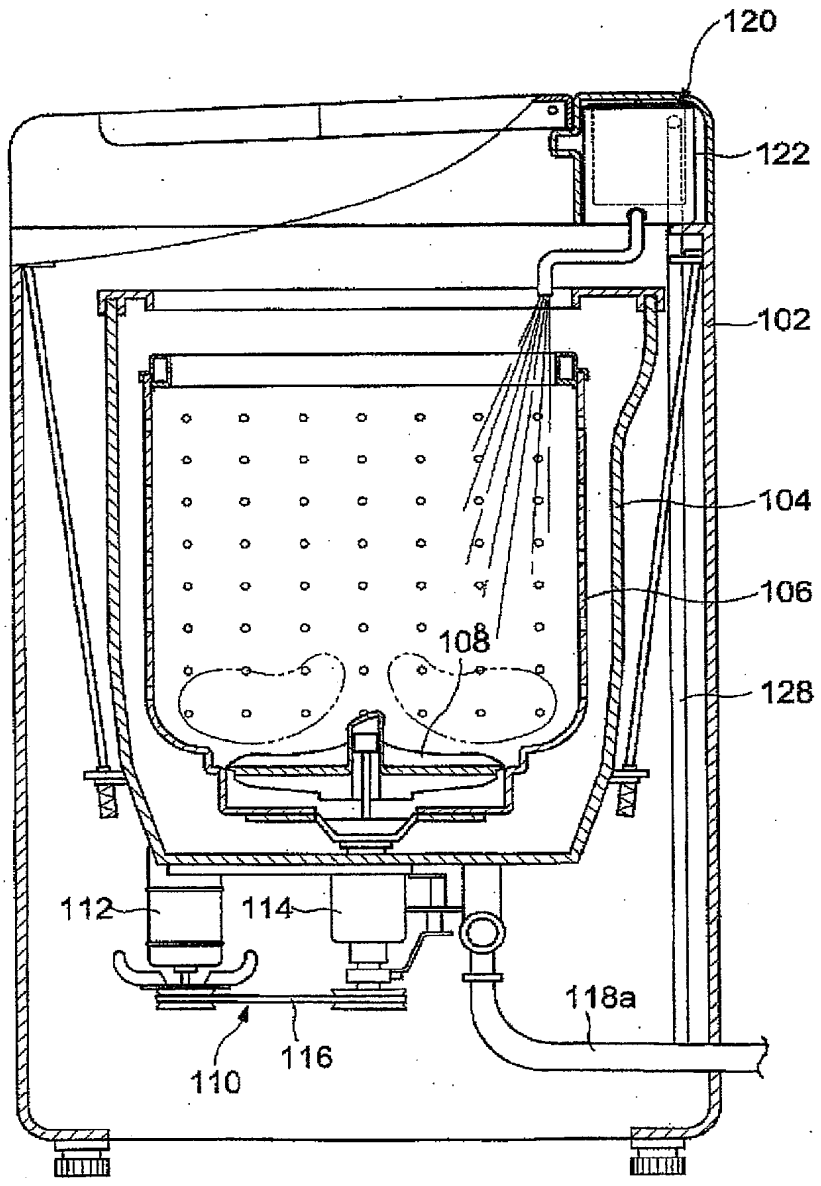


FIG. 2

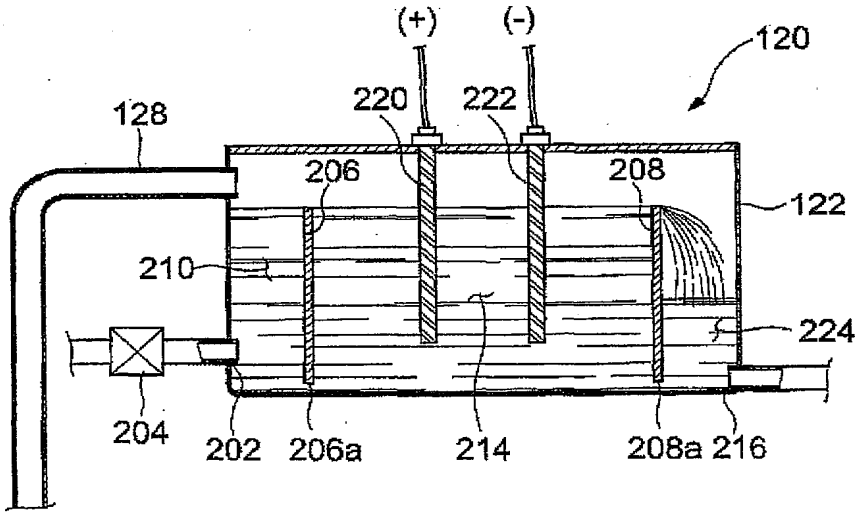


FIG. 3

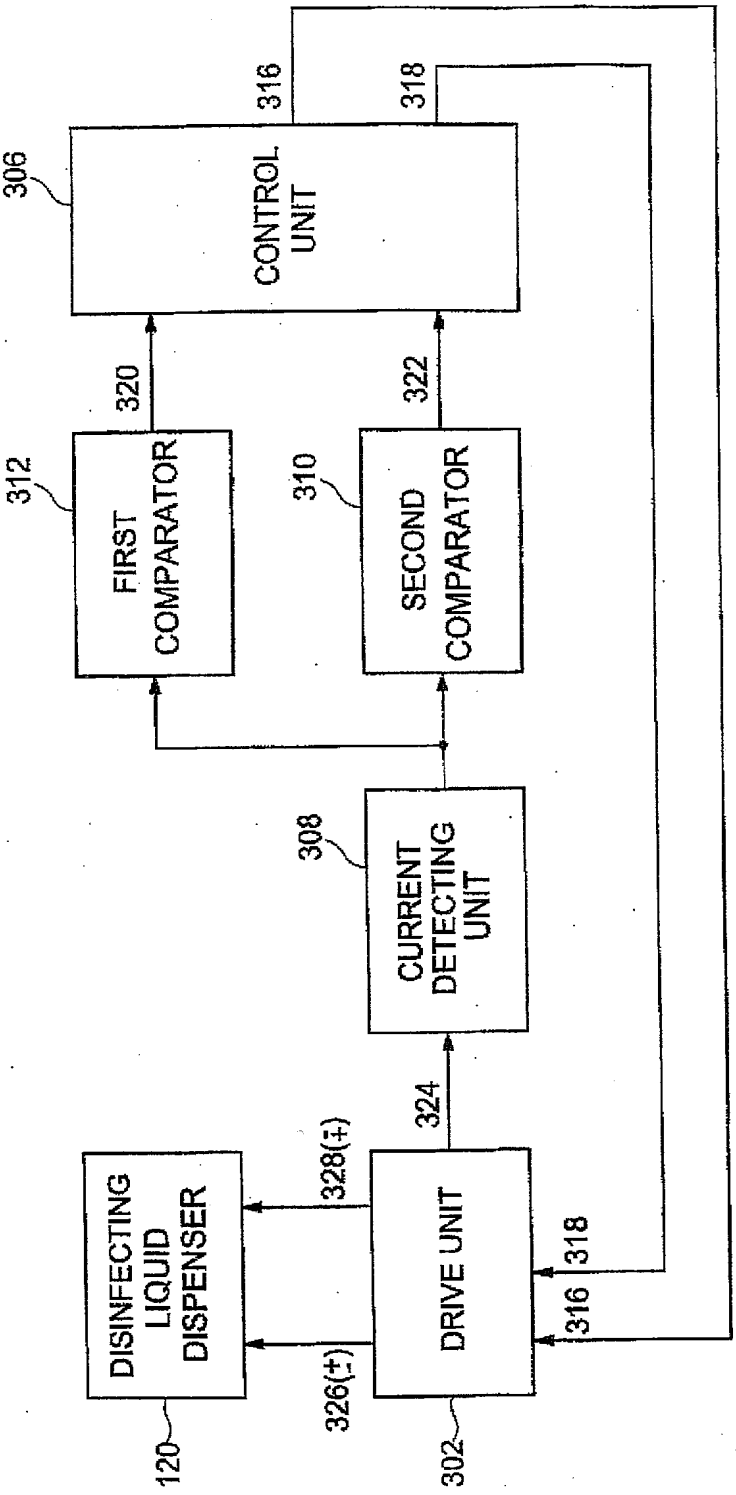
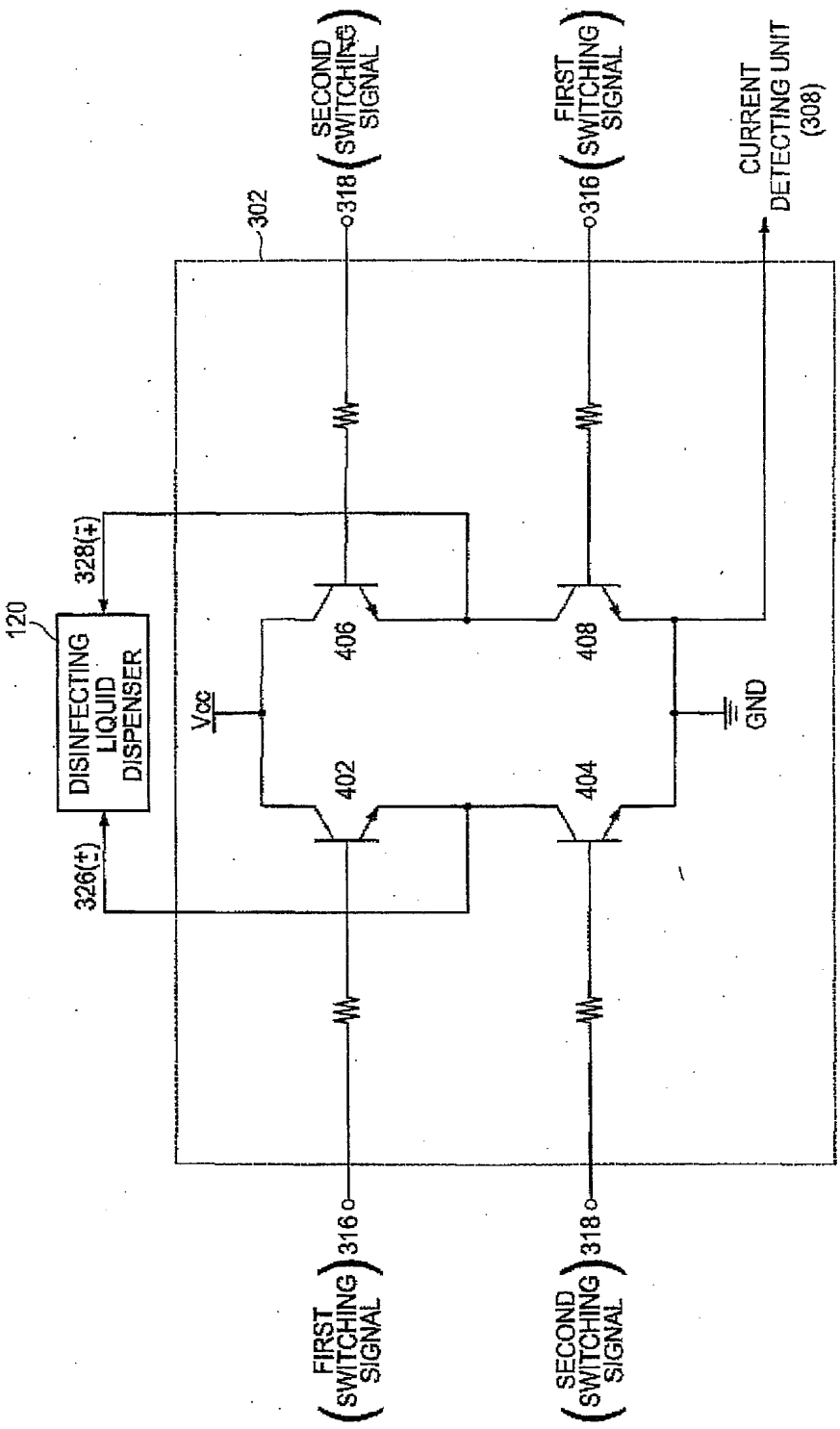

CONTROL UNIT
306
316
318
FIRST COMPARATOR
312
320
SECOND COMPARATOR
310
322
CURRENT DETECTING UNIT
308
DRIVE UNIT
324
328(+)
326(-)
316
318
DISINFECTING LIQUID DISPENSER
120
302

FIG. 4


120
DISINFECTING LIQUID DISPENSER
328(+)
326(-)
302
SECOND SWITCHING SIGNAL
318
FIRST SWITCHING SIGNAL
316
CURRENT DETECTING UNIT (308)
Vcc
GND
406
408
402
404
FIRST SWITCHING SIGNAL
316
SECOND SWITCHING SIGNAL
318

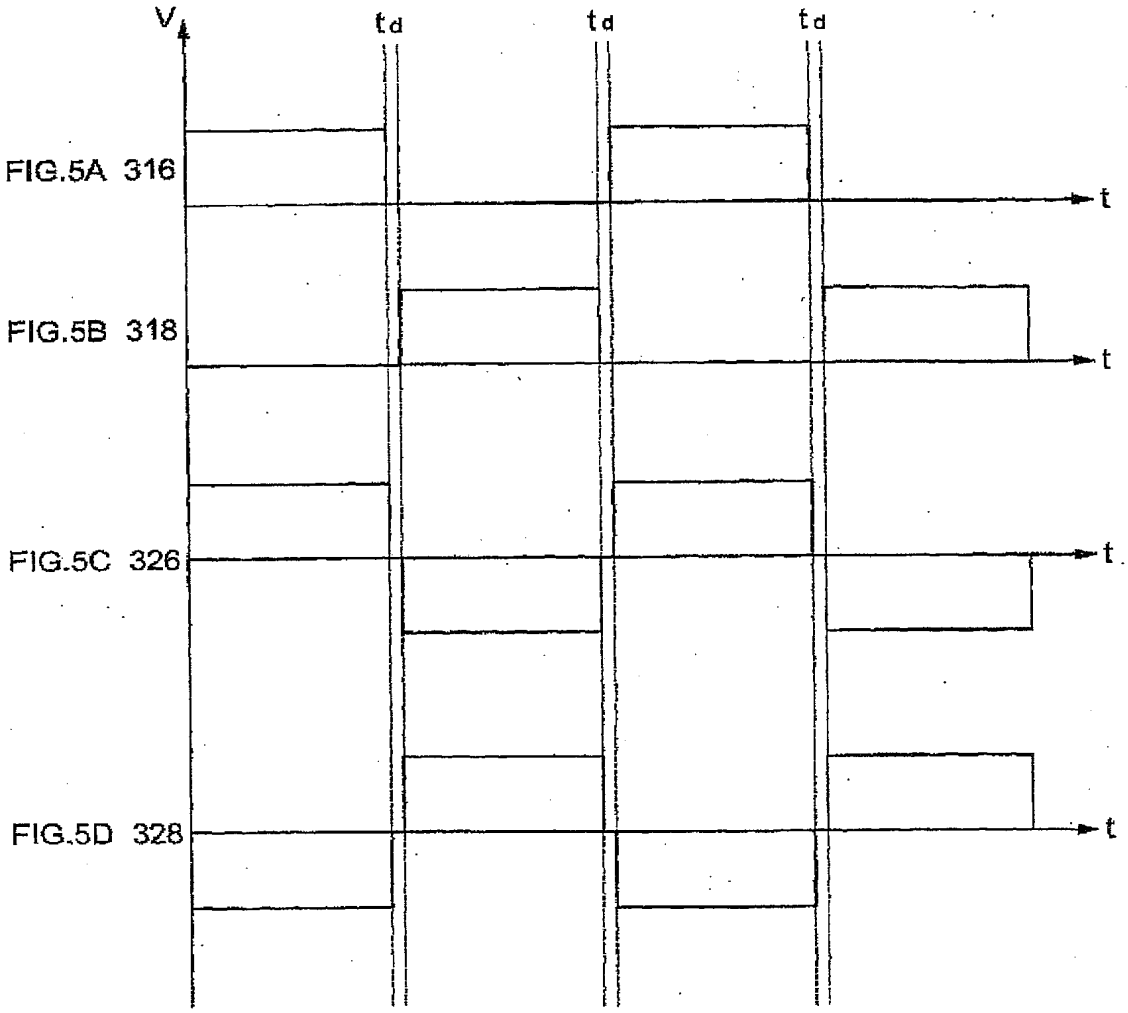
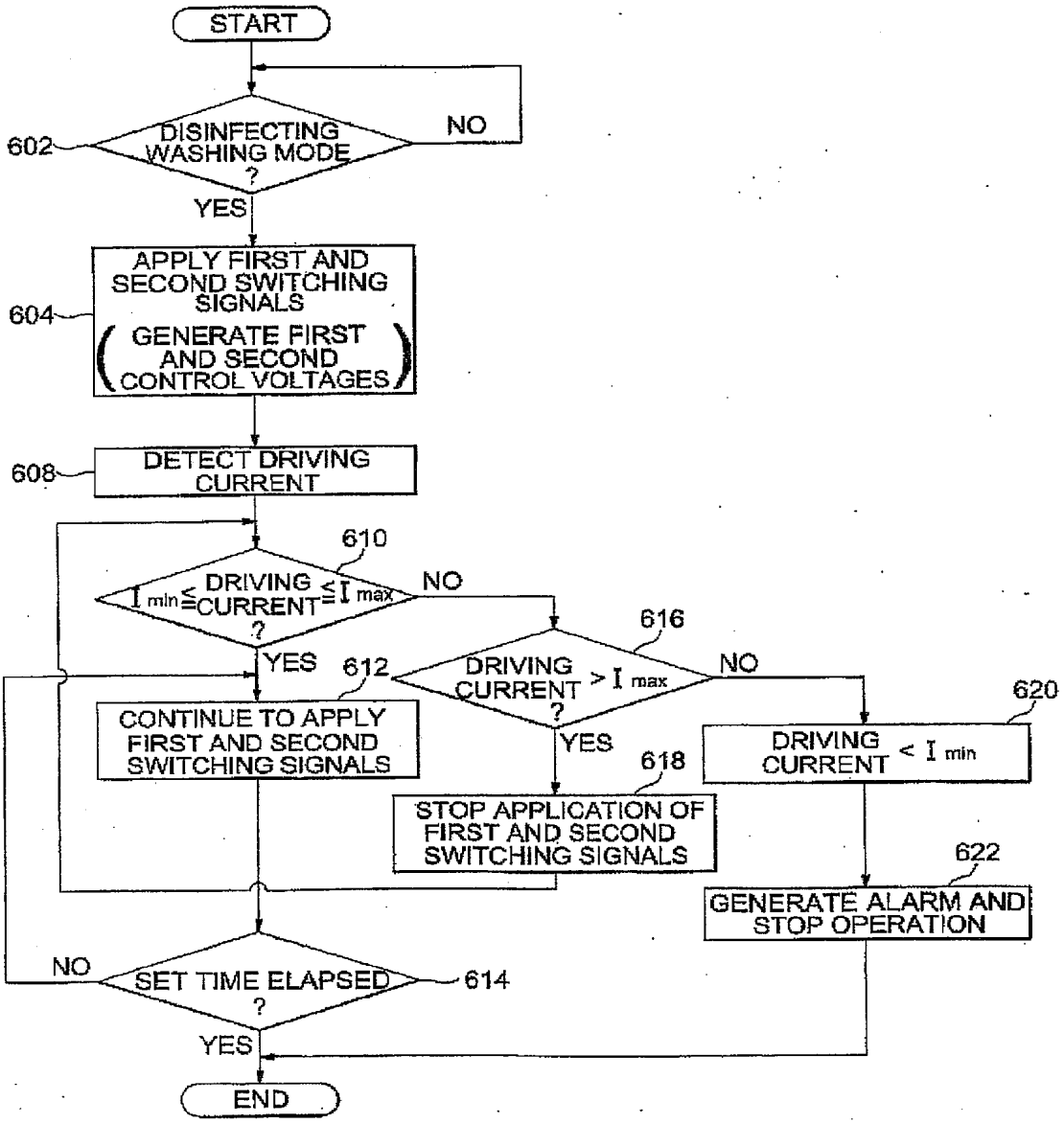

V
td
td
td
FIG.5A 316
FIG.5B 318
FIG.5C 326
FIG.5D 328
t
t
t
t

FIG. 6


START
602
DISINFECTING WASHING MODE ?
NO
YES
604
APPLY FIRST AND SECOND SWITCHING SIGNALS
( GENERATE FIRST AND SECOND CONTROL VOLTAGES )
608
DETECT DRIVING CURRENT
610
I min ≤ DRIVING CURRENT ≤ I max ?
NO
YES
616
DRIVING CURRENT > I max ?
NO
YES
612
CONTINUE TO APPLY FIRST AND SECOND SWITCHING SIGNALS
618
STOP APPLICATION OF FIRST AND SECOND SWITCHING SIGNALS
620
DRIVING CURRENT < I min
622
GENERATE ALARM AND STOP OPERATION
NO
SET TIME ELAPSED ?
614
YES
END